

DRIP IRRIGATION HOSE WITH ROOT DETERRENT STRIP2nd H  
BACKGROUND OF THE INVENTION

Drip irrigation systems have come into widespread use in the agricultural area. Drip irrigation systems supply water at a slow, controlled rate to the root zone of the particular plants being irrigated. Typically, drip irrigation is accomplished by providing a low volume water outlet at each plant that permits a limited dripping of water directly to the root zone of the particular plant. These hoses are usually installed slightly underground to protect them from wind, rodents, sun and machinery and to aid the flow of the water into the soil.

One of the problems with such a drip irrigation installation is that, if the farmer does not irrigate enough to satisfy the needs of the plants, roots will grow to find more water. As the hose usually has some residual water left in it, the roots will seek the water, entering the water outlet and eventually plugging it. When this process starts, uniformity of water distribution becomes erratic, and shortly unsatisfactory crop response results.

## SUMMARY OF THE INVENTION

The present invention provides a novel solution to root ingrowth. In one embodiment, the invention is directed to a drip irrigation hose having an interior surface, an exterior surface and a water supply passage extending therethrough. One or more outlets are provided that connect the water supply passage to the exterior of the hose. One or more root deterrent strips are attached to the interior surface or the exterior surface of the hose at or near the outlets. Each root deterrent strip comprises a fabric strip impregnated with a chemical herbicide.

In a particularly preferred embodiment, the invention is directed to a drip irrigation hose having an interior surface, an exterior surface, a water supply passage and a plurality of flow regulating channels that are smaller than the water supply passage. The flow regulating channels each comprise an inlet section comprising one or more openings connecting the water supply passage to that flow regulating channel, and an outlet section comprising one or more openings connecting that flow regulating channel to the exterior of the hose. The hose further comprises one or more root deterrent strips as described above attached to the interior surface or the exterior surface of the hose at or near the openings of the inlet section or the outlet section.

## DESCRIPTION OF THE DRAWINGS

These and other features and advantages of the present invention will be better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a cross-sectional view of a drip irrigation hose having a flow regulating channel between its margins.

FIG. 2 is a top sectional view of a flow regulating channel according to the invention.

1 FIG. 3 is a schematic block diagram of the method for making a drip irrigation hose of the continuous emitter type.

FIG. 4 is a schematic view of a portion of the film path for making a drip irrigation hose in accordance with the invention.

5 FIG. 5A is a side partial cutaway view of an irrigation hose according to the invention having a longitudinal root deterrent strip attached to the exterior of the hose over the outlets.

FIG. 5B is a side partial cutaway view of an irrigation hose according to the invention having a root deterrent strip wrapped around the exterior of the hose over the outlets.

10 FIG. 5C is a side partial cutaway view of an irrigation hose according to the invention having a longitudinal root deterrent strip attached to the interior of the hose over the outlets.

FIG. 5D is a side partial cutaway view of an irrigation hose according to the invention having a root deterrent strip wrapped around the interior of the hose over the outlets.

FIG. 5E is a side partial cutaway view of an irrigation hose according to the invention having a longitudinal root deterrent strip attached to the exterior of the hose near the outlets.

15 FIG. 5F is a side partial cutaway view of an irrigation hose according to the invention having a root deterrent strip wrapped around the exterior of the hose near the outlets.

#### DETAILED DESCRIPTION

20 The present invention employs a root deterrent strip attached to the interior or exterior of the hose to discourage root intrusion. The root deterrent strip comprises a fabric strip impregnated with a chemical herbicide. The invention provides a mechanism for keeping the herbicide in close proximity to the outlet(s) of the hose without blocking water flow.

25 As shown in FIGs. 1, 2 and 5, a flexible drip irrigation hose 10 (commonly referred to as "tape") is made from an elongated strip of plastic film 14, which is typically 4 to 15 mil thick. The film 14 can be made of any suitable material, for example, a laminate of high density polyethylene or polypropylene. Film 14 is folded longitudinally to form overlapping inner and outer longitudinal margins 16 and 18, thus creating a seam. A first longitudinal rib 20 partially seals margins 16 and 18. A second longitudinal rib 22, outboard of rib 20, completely seals margins 16 and 18. Ribs 20 and 22 contain a repeating longitudinal pattern that defines a series of small flow regulating channels 24 along the length of the hose 10. By virtue of the longitudinal fold in film 14, the interior surface of film 14 defines a relatively large water supply passage 26. The water supply passage 26 is connected to a source of water under pressure, not shown. Examples of such constructions are described in U.S. Patent Nos. 4,247,051, 4,984,739, 5,282,578, and 5,522,551, the disclosures of which are incorporated herein by reference.

30 As shown in FIG. 2, the flow regulating channels 24 (i.e., emitter regions) each have an inlet section 28, a turbulent flow section 30, and an outlet section 32. For each flow regulating channel 24, the inlet section 28 comprises one or more inlet openings to allow water to flow from the water supply passage 26 into the flow regulating channel 24. In the depicted embodiment,

1 the inlet section 28 comprises a plurality of pillars 36 between which are formed openings 38. As would be recognized by one skilled in the art, the inlet section 28 can have any other design that permits water to enter the flow regulating channel 24 from the water supply passage 26.

5 The flow regulating channels 24 each have a much smaller cross-sectional area than the water supply passage 26. The cross-sectional area of the water supply passage 26 is preferably from about 20 to 300 times, more preferably from about 50 to 200 times, larger than the cross-sectional area of the flow regulating channel 24. Accordingly, each flow regulating channel 24 creates a passage between the water supply passage 26 and the outside of the hose 10 that controls the flow rate of the water flowing through it.

10 The flow regulating channels 24 can have any other design as is known in the art. For example, the turbulent flow section 30 can be formed of a series of chevrons, by a series of walls that form a serpentine path, or by any other configuration that creates turbulent flow. However, the turbulent flow section can be omitted if desired and replaced with a straight-path channel.

15 FIGs. 3 and 4 depict a method for making the drip irrigation hose shown in FIG. 1. As represented by a block 70, the outlets 44 are first formed in film 14. Preferably each outlet 44 comprises a single longitudinal slit in the film 14, but could also be any other type of slit. A preferred method and apparatus for forming a knife-formed longitudinal slit outlet is described in U.S. Patent No. 5,522,551, the disclosure of which is incorporated herein by reference. Any other suitable method known in the art for providing outlets can also be used. For example, the surface of one of the outer margins 18 can be deformed to form protrusions in the film surface, and thereafter the protrusions are sliced from the film to form outlets, as described in U.S. Patent No. 5,123,984, the disclosure of which is incorporated herein by reference. Alternatively, the outlet section can comprise a plurality of pillars between which are formed outlet openings, in a manner similar to the inlet section described above.

25 As represented by block 72, the inner margin 16 is then folded. As represented by block 74, one or more beads are laid on the outside surface of the inner margin 14 by one or more extrusion nozzles. As represented by block 76, a pattern is formed in ribs 20 and 22 by a molding wheel. As represented by block 78, outer margin 18 is then folded onto inner margin 16, with the formed ribs therebetween. Finally, as represented by block 80, flow regulating passage 24 is finished by passing inner margin 16, outer margin 18, and the ribs 20 and 22 through the nip of a form wheel and a backing wheel to set precisely the height of the ribs.

30 FIG. 4 illustrates an assembly station for performing the above-described steps. One or more extrusion nozzles 82 deposit one or more continuous longitudinal beads 84 (in the form of hot molten glue or resin) on the outside surface of the inner margin 16. The film 14 is passed through the nip of a rotating molding wheel 86 and a rotating backing wheel 88. The molding wheel 86 contains a pattern of depressions 90 corresponding to the desired raised rib pattern, i.e., a pattern such as that shown in FIG. 2. In the nip, beads 84 are shaped by molding wheel 86 to form the desired bead pattern on film 14 for the entire length of the hose 10. After leaving the

1 nip of wheels 86 and 88, the external margin 18 of the film 14 is folded by a guide 92 to overlap  
the inner margin 16. Finally, the overlapped margins of the film 14 pass through the nip of a  
form wheel 94 and a second backing wheel 96. The form wheel 94 has a groove 98 that  
depresses the ribs formed by the beads 84 to set the rib height at a specified value that determines  
5 the flow rate of the hose 10. During the described process, the film 14 is continuously  
transported by a conventional means, not shown. For example, the disclosed wheels could be  
driven, or other drive wheels could be provided, to transport the film.

Also, as would be recognized by one skilled in the art, the flow regulating channels 24  
need not be formed in the margins 16 and 18 of the hose 10, but can be provided at any location  
10 on the hose. For example, it is known in the art to provide discrete flexible emitters (not shown)  
that are adhered or otherwise bonded to the interior or exterior of the hose, with each emitter  
having an inlet in communication with the water supply passage and an outlet to the exterior of  
the hose, as described above. The emitters can be attached to the inside or outside of the hose  
by any of several methods including, but not limited to, adhesive bonding, solvent bonding,  
15 thermal bonding, and ultrasonic welding. For example, flexible discrete external emitters can  
be attached to the exterior of the hose, as described in U.S. Patent Application No. 09/136,354,  
entitled "External Emitter for Drip Irrigation Hose", the disclosure of which is incorporated by  
reference.

Alternatively, a continuous emitter can be bonded to the hose, where the continuous  
emitter has a series of flow regulating channels along its length, inlets in communication with  
the water supply passage and outlets to the exterior of the hose, as described above. The  
continuous emitter can be manufactured into the irrigation hose by bonding it to the hose in any  
suitable manner known in the art, such as those described above. For example, the emitter can  
be extruded and formed by means of an embossing or imprinting tool. This technique is  
25 particularly useful if the hose is also being extruded. Thus, a continuous emitter could be  
extruded and formed, then inserted into a die center around which a hose is extruded. As the  
emitter and hose are extruded together, the emitter would be formed and adhered to the hose  
before it is cooled. Alternatively, the continuous emitter could be extruded and formed offline,  
and then fed through a hole in the die through which a hose is extruded. In another embodiment,  
30 the continuous emitter could be fed and joined to a long continuous strip that is then folded to  
form a hose.

In another embodiment, the drip irrigation hose is a hard hose having a plurality of discrete  
emitters (i.e., flow regulating channels) provided therein, as is known in the art and described,  
for example, in U.S. Patent Nos. 5,111,996 and 4,824,025.

35 A root deterrent strip 40 is attached to the interior or exterior of the hose 10 at or near the  
outlet(s) 32 to discourage root intrusion. The root deterrent strip 40 can be attached to the hose  
by any suitable means, such as bonding or, wrapping the fabric around the hose. FIG. 5A shows  
a root deterrent strip 40 attached longitudinally to the exterior of the hose 10 over the outlets 32.

1 FIG. 5B shows a root deterrent strip 40 wrapped around the exterior of the hose 10 over the  
outlets 32. FIG. 5C shows a root deterrent strip 40 attached longitudinally to the interior of the  
hose 10 over the outlets 32. FIG. 5D shows a root deterrent strip 40 wrapped around the interior  
5 of the hose 10 over the outlets. FIG. 5E shows a root deterrent strip 40 attached longitudinally  
to the exterior of the hose 10 near, but not covering, the outlets 32. FIG. 5F shows wrapped  
around the exterior of the hose 10 near, but not covering, the outlets 32. As would be recognized  
by one skilled in the art, the root deterrent strip 40 could also be attached longitudinally to the  
interior of the hose 10 or wrapped around the interior of the hose near, but not covering, the  
10 outlets 32. An advantage of using an externally attached root deterrent strip 40 is that the strip  
acts as a wick to more uniformly distribute the water along the path of the hose. Alternatively,  
the root deterrent strip 40 can be positioned partially to cover the inlets to the flow regulating  
channel 24.

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15 The root deterrent strip 40 comprises a fabric strip impregnated with a chemical herbicide.  
The fabric is sufficiently porous to allow water to flow through it so that it may cover the interior  
or exterior of the outlet opening(s) and sufficiently absorbent to hold the herbicide. Suitable  
fabrics for use in connection with the present invention include, but are not limited to, felt,  
plastic, and nonwovens (natural and synthetic), preferably needle-punched nonwovens. Any  
suitable chemical herbicide, i.e., root intrusion deterrent composition, can be employed.  
Preferred compositions include dinitroanilines, such as TREFLAN™ (trifluralin, 4-  
20 trifluoromethyl-2,6-dinitro-N,N-dipropyl aniline), SONALAN™ (ethalfluralin), PROWL™  
(pendimethalin), and oryzalin (4-sulfonamido-2,6-dinitro-N,N-dipropyl aniline), dinoseb (2,4-  
dinitro-6-sec-butyl phenol), bromoxynil (3,5-dibromo-4-hydroxybenzonitrile), paraquat (1,1'-  
dimethyl-4,4'-bipyridinium dichloride), bromoxynil octanoic acid ester (3,5-dibromo-4-  
hydroxybenzonitrile octanoic acid ester), TBA (2,3,6-trichlorobenzoic acid), 2,4-D (2,4-  
25 dichlorophenoxy acetic acid), and copper hydroxide. In a particularly preferred embodiment, the  
root deterrent strip 40 is made of Tex-R™ Agroliner (commercially available from Texel,  
Henderson, North Carolina).

30 The above-described embodiments of the invention are only considered to be preferred  
and illustrative of the inventive concepts. The scope of the invention is not to be restricted to  
such embodiments. For example, as would be recognized by one skilled in the art, the invention  
is not limited to hoses having flow regulating channels, as described above, but can be used with  
any hose having a water supply passage and outlets along the length of the hose. Various and  
numerous other arrangements may be devised by one skilled in the art without departing from  
the spirit and scope of the invention.